

SYNONYMS OF *FRONTINELLA TIBIALIS* (ARANEAE, LINYPHIIDAE)

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ABSTRACT. Synonymy among three species of linyphid spiders of the genus *Frontinella* F. O. Pickard-Cambridge 1902 is established based on field association between males and females, mating records, and morphological data from recently collected specimens. It is concluded that *F. caudata* Gertsch & Davis 1946 and *F. lepidula* Gertsch & Davis 1946 are both junior synonyms of *F. tibialis* F. O. Pickard-Cambridge 1902. A redescription of this species is included.

RESUMEN. Se establece la sinonimia entre tres especies de arañas linífidas del género *Frontinella* F. O. Pickard-Cambridge 1902, con base en datos de campo sobre la asociación entre machos y hembras, registros de apareamientos, y datos de la morfología de especímenes recientemente colectados. Se concluye que *F. caudata* Gertsch & Davis 1946 y *F. lepidula* Gertsch & Davis 1946 son sinónimos junior de *F. tibialis* F. O. Pickard-Cambridge 1902. Se incluye una redescipción de esta especie.

Keywords: Linyphiidae, *Frontinella*, synonymy, Mexico, Chiapas.

The spider genus *Frontinella* was created by F. O. Pickard-Cambridge in 1902 for eight species found in Central and North America. Petrunkevitch (1911) made *Frontinella* a junior synonym of *Linyphia* Latreille 1804 without argument, but Blauvelt (1936) resurrected *Frontinella* from this synonymy when she made a revision of *Linyphia* and several related genera. Roewer (1942, 1954) and Bonnet (1956, 1957), in their respective catalogues, included *Frontinella* as a junior synonym of *Linyphia*, but they did not give any argument. Nevertheless, from that time on most authors considered *Frontinella* a valid genus name (Kaston 1938, 1948; Gertsch & Jellison 1939; Muma 1943; Brignoli 1983; Millidge 1984; Platnick 1989, 1993, 1997; Breene et al. 1993), and several new species were described (Gertsch & Davis 1946; Bryant 1948; Kraus 1955; Li & Song 1993). Millidge (1991) transferred *F. uncatata* F. O. Pickard-Cambridge 1902 to the genus *Novafrofrontina* Millidge 1991. At present there are 15 species worldwide, two from China and 13 from the Americas, with nine of these species reported from Mexico: *F. communis* (Hentz 1850), *F. laeta* (O. Pickard-Cambridge 1898), *F. bicuspis* F. O. Pickard-Cambridge 1902, *F. rustica* F. O. Pick-

ard-Cambridge 1902, *F. tibialis* F. O. Pickard-Cambridge 1902, *F. caudata* Gertsch & Davis 1946, *F. huachuca benevola* Gertsch & Davis 1946, *F. lepidula* Gertsch & Davis 1946 and *F. potosia* Gertsch & Davis 1946. Only two of these have been recorded for the state of Chiapas, Mexico: *F. caudata* and *F. lepidula* (Gertsch & Davis 1946; Hoffmann 1976).

In 1995, we collected female and male specimens of *Frontinella* in coffee plantations in southeast Chiapas. The female specimens were identified as *F. caudata*, some males as *F. tibialis*, and other males as *F. lepidula*. *Frontinella tibialis* and *F. lepidula* were described from only one male specimen each, *F. caudata* was described from only female specimens. We found accompanying males in the webs of several *F. caudata* females. Most of these were identified as *F. tibialis*, one as *F. lepidula*. The finding of these pairs suggests synonymy.

In their description of *F. lepidula*, Gertsch & Davis (1946) considered it near to *F. tibialis* but pointed out some differences: "This is a smaller species than *tibialis* Cambridge. The embolus of the male palpus is shorter and less strongly curved at the apex, and the pa-

tella of the palpus is armed with a long curved spine instead of a short spur." Some of our male specimens could not be assigned to any of these two species because they have a "short spur" in one patella and a "long spine" in the other, showing another indication of possible synonymy. Thus, we decided to collect more specimens of both sexes, to study and clarify the taxonomy of the three described species.

METHODS

The collecting site was the coffee plantation of the "Campo Agrícola Experimental Rosario Izapa" of the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP), Municipio of Tuxtla Chico, 20 km NNE of Tapachula, Chiapas, at 400 m elevation. This place was selected due to the abundance of *Frontinella*. The first collecting period was from September–November 1995, and the second in January 1998. The spiders were collected by visual search of the webs of adult and subadult females (as it is difficult to differentiate these two age classes in the field); additionally, some solitary males were collected to have enough specimens for the taxonomic study. All individuals found on the same web were put in the same container and preserved in 70% ethanol. In the laboratory each specimen was tentatively identified and the age class and sex was determined. Specimens were deposited at the Colección de Arañas del Sureste de México (ECOTA-AR, El Colegio de la Frontera Sur, Tapachula, Chiapas, Mexico), the American Museum of Natural History, New York (AMNH), and The Natural History Museum, London (NHM).

To study the specimens, we considered the characters in the original description of each species. All adults (females and males) were measured to compare their variability in relation to the measurements of the corresponding type as noted in the original descriptions. The measured characters were total length, carapace length, carapace width, and length of each segment of the first leg from femur to tarsus. Specimens of both sexes were sent to Dr. N. I. Platnick (AMNH), and to Mr. P. D. Hillyard (NHM), for comparison with the corresponding types in those museums. The paratypes of *F. caudata* and of *F. huachuca benevola*, deposited in the Colección Nacional de Arácnidos (CNAN, Dr. Tila María Pérez,

Instituto de Biología, Universidad Nacional Autónoma de México), were also examined for comparative analyses. We examined the patellar macroseta of both palpi for each collected male, and made some SEM photographs of them. Additional information about the type specimens, not included in the original descriptions, was provided by Dr. N. I. Platnick and by Mr. P. D. Hillyard. The descriptions in the taxonomic section were based on the specimens collected in this work, with each measurement noted as average and range of variation (minimum and maximum); all measurements are in millimeters. Abbreviations used in text: ALE: anterior lateral eyes; AME: anterior median eyes; PLE: posterior lateral eyes; PME: posterior median eyes. Fe-I (II, III, IV): first femora (second, third, fourth); Me-I (II, III, IV): first metatarsi (second, third, fourth); Pa-I (II, III, IV): first patellae (second, third, fourth); Ta-I (II, III, IV): first tarsi (second, third, fourth); Ti-I (II, III, IV): first tibiae (second, third, fourth). Cy: cymbium; PCy: paracymbium.

RESULTS

We collected 76 individuals from 55 webs: 39 webs were occupied by only one individual (solitaries), the remaining 16 webs contained 37 spiders, from two to five individuals per web (Table 1). Most accompanied adult females shared the web with only one male, but a few were found with several males. Most sub-adult females were alone on their webs, only one was found with a male. Inexplicably, one sub-adult female and one juvenile were found each on the web of an adult female. Most males were found on the webs of adult females, but two males were each on the web of a juvenile (Table 1).

In one web, one adult female was found with four males (Table 2), and we observed the end of copulation between one of these males and the female. On a date subsequent to the sampling period, one of the authors (J. A. García) observed another pair in a web, copulating at least two times during the 30 min of observation.

The measurements from 30 collected females showed that most mean values of these females are slightly smaller than those of the *F. caudata* holotype and paratype, but the variation of these types are well inside the variation ranges of the collected females. Besides

Table 1.—Numbers of specimens collected on each web, with their corresponding sex/age. F = female(s), M = male(s).

	Adult F	Sub-adult F	Adult M	Juveniles	No. in web totals
Solitarities	18	14	7		39
with F		1	16	1	18
with 1 M	8	1		2	11
with >1 M	3				3
with sub-adult F	1		1		2
with juveniles	1		2		3
Age/sex totals	31	16	26	3	76

the size variations, the study of the adult females showed no major differences among them, nor in respect to the characters noted in the description of *F. caudata*, or those observed in the paratype of this species. The epigyna were very similar for all females, paratype included, in respect to form and position of the openings, dorsal and ventral plates (as defined by Millidge 1984). Although some variability was recorded in the form and size of the opisthosoma and its caudal tubercle, this could be due to differences in nutritional condition, level of development of ovaries, or natural variability.

Gertsch & Davis (1946) considered the length of the patellar macroseta, and length and curvature of the embolus as distinctive characteristics between *F. tibialis* and *F. lepidula*. The collected male specimens showed only slight variability among them in embolus characteristics. On the contrary, for the length of the patellar macroseta we found two states, the "short spur" of Gertsch & Davis (as in the figs. 7a and 7b of *F. tibialis* by F. O. Pickard-Cambridge 1902, table XL), or the "long spine" (as in fig. 11 of *F. lepidula* by Gertsch & Davis 1946).

We found males with "long spines" on both palpi, males with "short spurs" on both palpi, but also males with a "short spur" on one palp and a "long spine" on the other (Table 2). This mixed condition seems to indicate that the macroseta is originally long, but it can break and lose its slender distal part, with only the thick base remaining. SEM images showed that the "short spur" is a patellar macroseta broken in the area where its diameter is reduced (Figs. 1, 2).

Our data also show that both solitary and courting males (in the web of a female) show the three conditions. Likewise, one female specimen was accompanied with males showing these three conditions (Table 2). Also, the male observed copulating with a female on a date subsequent to the collect period had a broken macroseta in one palp and a complete macroseta in the other.

As for the females, the measurements of the collected male specimens showed also overlapping ranges of size among them, and with the holotype of *F. lepidula*. It was also found that the collected males have a mastidion on each chelicera (one small laterally directed tubercle at the anterior proximal surface of the

Table 2.—Numbers of specimens collected alone or accompanied, and the pedipalp-patella macrosetae condition of the corresponding males. F = female, M = male(s), BM = broken macroseta, CM = complete macroseta. * The values with the same subscript letter corresponds to the same female specimen.

	M with 2 CM	M with 2 BM	M with 1 CM and 1 BM
Solitary M	2	2	3
1 F with 1 M	2	4	2
1 F with > 1 M*	2 _b + 1 _c	2 _a + 1 _b + 1 _c	1 _b
1 subadult F with 1 M	1		
1 juvenile F with 1 M		2	
Totals	8	12	6

cheliceral base, just below the clypeus). The mastidion size is variable, from sharply pointed in some specimens to blunt and very reduced in others. Some specimens have mastidia of different size, one pointed and one reduced. In some of the males, the chelicerae were so retracted that the mastidion was not directly visible because it was covered by the clypeus, but a careful examination showed its presence in all collected males.

DISCUSSION

In some linyphiid species, the males respond to a species-specific sex pheromone present in the silk of adult female webs by approaching the female and initiating courtship behavior; in some cases the males can stay in the web for some time, and even copulate several times with the female (Rovner 1968; Austad 1982; Suter & Renkes 1982; Watson 1986, 1995; Wiley-Robertson & Adler 1994). The presence of the males in the females' webs, and the copulations observed constitute sound evidence of conspecificity, especially since no other related species were found at the collecting site.

The morphological similarity between the collected females and the paratype of *F. caudata* (especially with regard to the epigynum), and the fact that the measurements of the holotype and paratype of this species are inside the ranges of the collected females, indicate that *F. caudata* and the collected specimens are the same species.

Platnick (pers. comm.) considered a female specimen sent to him as the same species as the *F. caudata* holotype, and the male specimens sent to him as the same species of the *F. lepidula* holotype. For the male specimens sent to be compared with *F. tibialis*, Hillyard (pers. comm.) considered that "the pedipalp macroseta is not significantly different", but that "there is some doubt that these two species are conspecific", because he noted some differences such as total length ("the type is slightly larger"), the size of the palp ("more robust in the type"), the shape of the embolus (broader and more curved at its tip), and the presence of mastidia ("the type does not have a single mastidion on the basal segment of each chelicera").

In the original description of *F. tibialis*, F. O. Pickard-Cambridge (1902) noted only the total length, which is not a reliable character

because of the variability of the opisthosomal size in spiders (Blauvelt 1936; Hormiga 1994a). It was not possible to obtain other measurements from this type. Nevertheless, the maximum value of total length found from our specimens is only slightly below of that noted for the type of *F. tibialis* (4.4 vs. 4.5). Additionally, there is a high variability in size in the collected male specimens, where the smallest male is only one half of the largest (2.2 to 4.4). Furthermore, the range of variation for each measured character overlapped among the three variants of the collected males (with 2 complete macroseta, with 2 broken macroseta, and with one complete and one broken macroseta), and the measurements of the *F. lepidula* holotype were also inside these variation ranges. As *F. tibialis* was described from only one specimen, there were no records about its size variability. Thus, the slight difference in size does not contradict the conspecificity of our specimens with the type of *F. tibialis*.

Concerning the differences between *F. tibialis* and *F. lepidula* in size and curvature of the embolus mentioned by Gertsch & Davis (1946), we consider these as minor differences in comparison with other *Frontinella* species (judging from the drawings of F. O. Pickard-Cambridge 1902; Blauvelt 1936; Gertsch & Davis 1946; and Song et al. 1999), where the pedipalpal bulbs (subtegulum, tegulum, embolic division, particularly the embolus and lamella characteristica) are conspicuously different among species. When the palpal bulb of the collected specimens is observed from different angles the embolus becomes more or less curved, and the lamella characteristica becomes more or less wide. Additionally, the type of *F. tibialis* comes from a locality near the Gulf of Mexico coast, but the type of *F. lepidula* and the males we collected come from a locality near the Pacific coast of Mexico; therefore, it is possible that these are opposite ends of a geographic variability spectrum concerning the size and curvature of the embolus.

F. O. Pickard-Cambridge (1902) noted explicitly in his key to *Frontinella* species that *F. tibialis* lacks mastidia, but all our male specimens have one on each chelicera, although sometimes a very reduced one. The presence of mastidia was not mentioned by Gertsch & Davis (1946), but Platnick (pers.

comm.) confirmed its presence in the *F. lepidula* holotype. Most species of *Frontinella* with known males have a mastidion on their chelicerae: *F. laeta* and *F. bicuspis* (F. O. Pickard-Cambridge 1902), *F. communis* (Blauvelt 1936), *F. huachuca* and *F. huachuca benevola* (Platnick pers. comm. and personal observation of the male paratype of *F. huachuca benevola* in the CNAN). Thus, the presence of mastidia seems not to be rare in this genus. The collected male specimens showed a high variability in the size of their mastidia. As *F. tibialis* was described from only one specimen, there were no records about mastidion variability. Also, it is possible that this difference corresponds to a spectrum of variability between the two populations (Gulf coast and Pacific coast).

Gertsch & Davis (1946) said about *Frontinella*, "It is notable that the males of the three new species herein described all have the patella of the palpus set with a long dorsal spine. In all the other known species this spine is modified into a short spur." As both species, *F. tibialis* and *F. lepidula*, were described each with only one specimen, the variation existing in this character was not observed. We do not know when and how the patellar macroseta breaks. As they are present only in the males, it is possible that these structures are related to reproductive activities. It would be necessary to study the reproductive behavior of this species to know more about the function of this structure.

Other similarities that support the hypothesis of conspecificity between the type of *F. tibialis* and the collected male specimens are the presence of macrosetae in the mesal border of the cymbium (Fig. 7), the relative size between pedipalp's patella and the tibia (tibia about twice as long as patella), the form of the pedipalp's tibia (widening to its distal end, Figs. 6–8), and the form of the male sternum, narrowly produced between coxae IV (as in table XL, fig. 7 of F. O. Pickard-Cambridge 1902).

From this evidence, we conclude that *F. caudata* and *F. lepidula* are junior synonyms of *F. tibialis* by the principle of priority (Article 23 of the ICZN). As the original description of *F. tibialis* is very short, we include here a redescription of this species based on the specimens collected in this work.

TAXONOMY

Figs. 1–10

Frontinella tibialis

F. O. Pickard-Cambridge 1902

Frontinella tibialis F. O. Pickard-Cambridge, 1902: 422, plate XL figs. 7a–b ♂; Gertsch & Davis, 1946: 3.

Linyphia tibialis, Petrunkevitch 1911: 255; Roewer 1942: 591; Bonnet 1957: 2531.

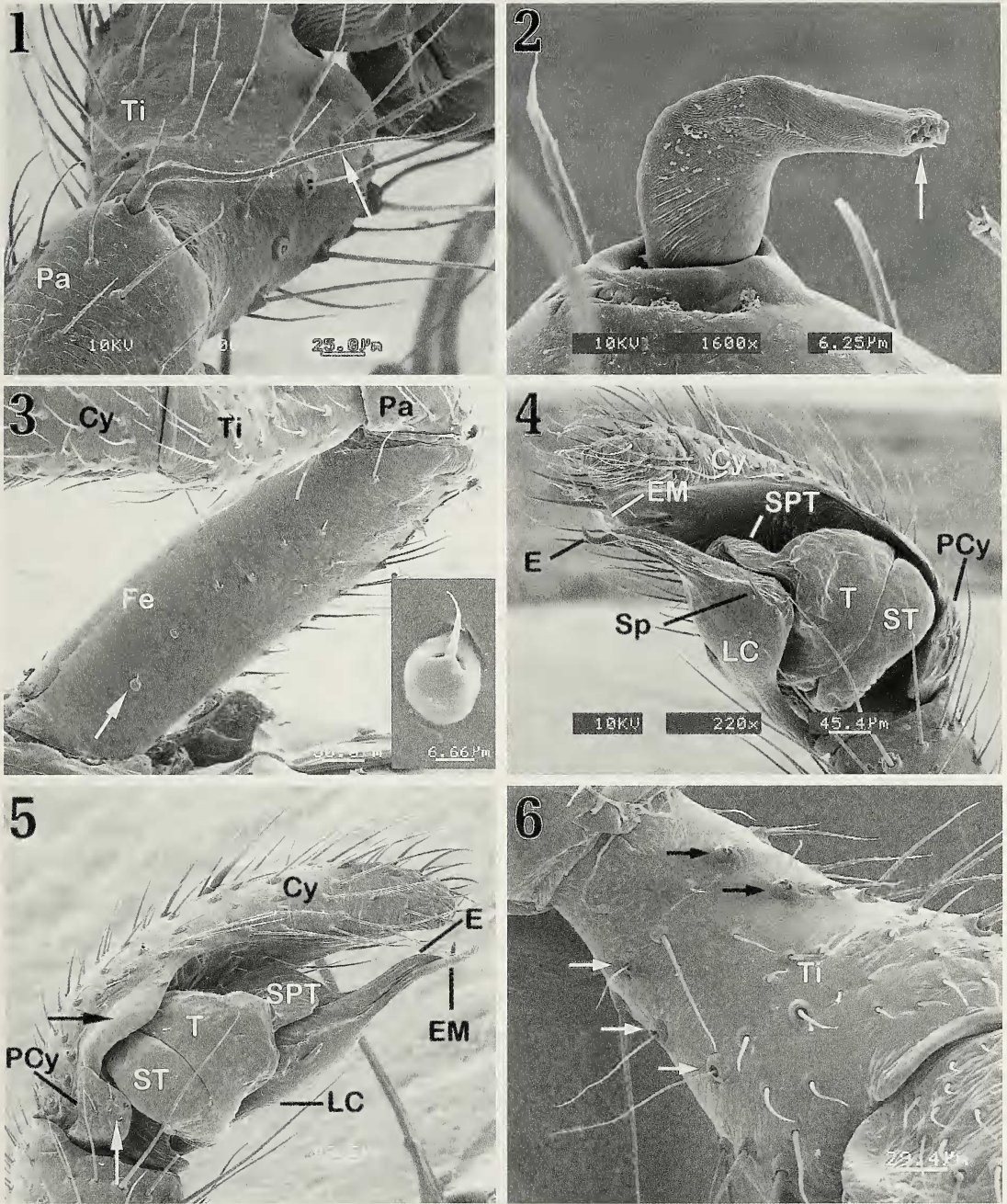
Frontinella caudata Gertsch & Davis, 1946: 4, fig. 6 ♀; Brignoli 1983: 294. NEW SYNONYMY.

Frontinella lepidula Gertsch & Davis, 1946: 4–5, figs. 10–11 ♂; Brignoli 1983: 294. NEW SYNONYMY.

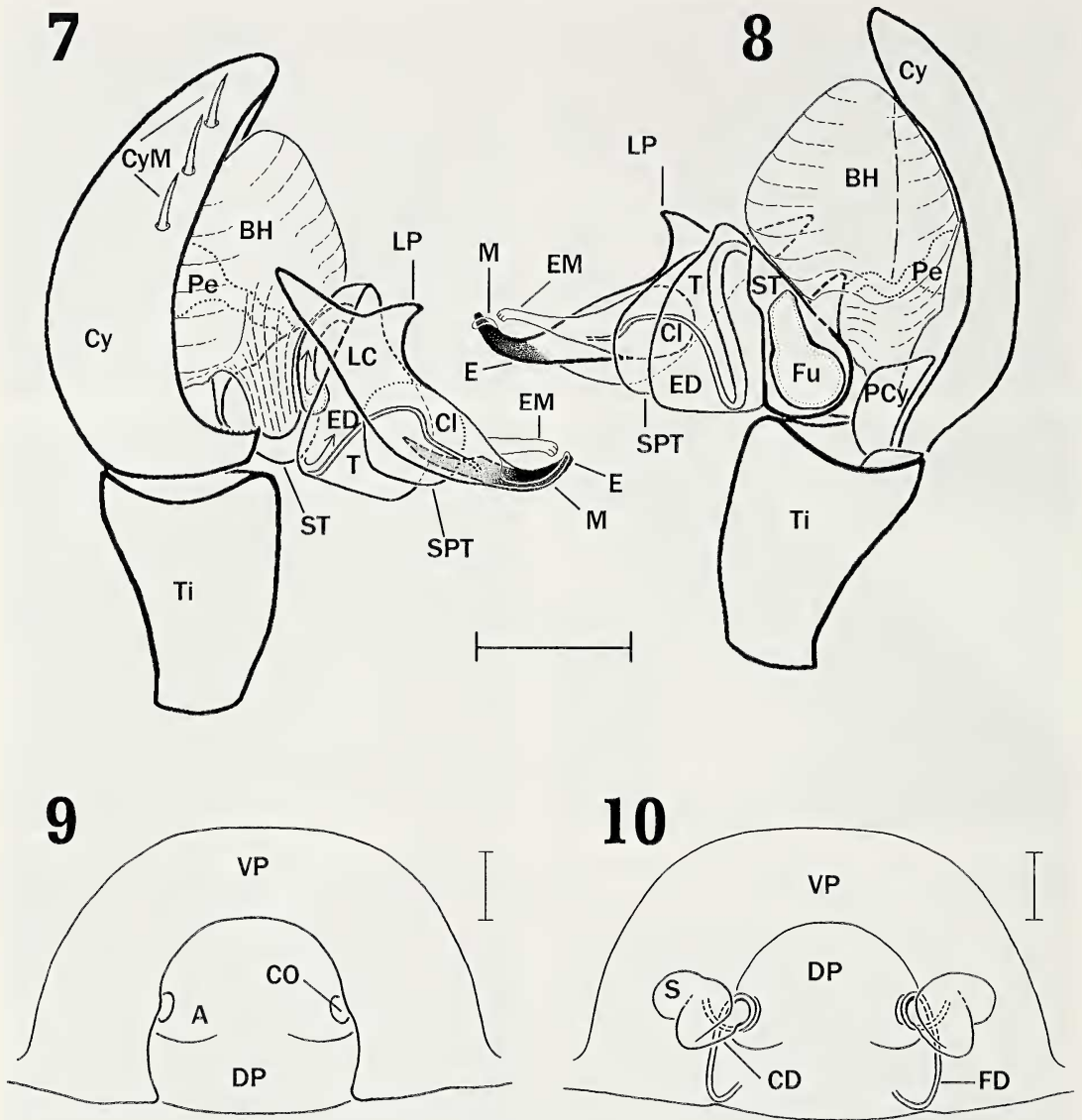
Types.—Male holotype of *F. tibialis* from Teapa, Tabasco, Mexico, in the collection of Goodman & Salvin, deposited in NHM (not examined). Female holotype of *F. caudata* from Chilpancingo, Guerrero, Mexico, deposited in the AMNH, female paratypes from Chilpancingo, Guerrero, Mapastepec and Tapachula, Chiapas, Mexico, deposited in the AMNH and in the CNAN (examined). Male holotype of *F. lepidula* from Tonala, Chiapas, Mexico, deposited in the AMNH (not examined).

Diagnosis.—This is a tentative diagnosis, because several species of this genus are known only from one sex, and we did not revise this genus. A possible autapomorphy of this species is the distinctive form of the lamella characteristica in the male pedipalp (Figs. 4, 7), clearly different from that of all other known males. The tibia's relative length, twice as long as the patella in the male pedipalp (Fig. 3), separates this species from most other species with known males (with tibiae less than twice the patella length), except from *F. potosia*, but in *F. potosia* the patellar macroseta of the pedipalp does not have a widened base as in *F. tibialis*. The position of the copulatory openings (on the lateral borders, about at the middle of the distance between the anterior and posterior borders of the dorsal plate, Fig. 9) distinguish this species from most other species with known females (having the copulatory openings on the anterior border of the dorsal plate), except from *F. zhui* Li & Song 1993, but in this species the posterior border of the dorsal plate is notoriously rounded and extended backwards.

Description.—*Male:* ($n = 26$) Total length 3.25 (2.16–4.43), carapace length 1.49 (0.97–1.86), carapace width 0.98 (0.70–1.20). Di-



Figures 1–6.—*Frontinella tibialis*, scanning electron micrographs of male pedipalp structures: 1. Complete macroseta of patella; 2. Broken macroseta of patella showing fracture point; 3. Row of setigerous cusps on mesal face of right femur, with enlargement of one cusp (inset) (scale bar for femur 50.0 μm); 4. Ectoventral view of left pedipalp showing visible parts in unexpanded condition; 5. Ectodorsal view of right pedipalp in unexpanded condition showing paracymbium with setae (white arrow) and membrane of cymbium (black arrow) (scale bar 46.5 μm); 6. Dorsal view of right tibia showing three retrolateral (white arrows) and two prolateral (black arrows) trichobothria (scale bar = 29.4 μm). *Abbreviations:* Cy = cymbium; E = embolus; EM = embolic membrane; Fe = femur; LC = lamella characteristic; Pa = patella; PCy = paracymbium; Sp = spine of lamella characteristic; SPT = suprategulum; ST = subtegulum; T = tegulum; Ti = tibia.



Figures 7-10.—*Frontinella tibialis*, drawings of genitalia. 7-8. Left male pedipalp with expanded bulb. 7. Meso-ventral view; 8. Ecto-dorsal view; 9-10. Female epigynum. 9. Ventral view; 10. Dorsal view of cleared epigynum. Scale bars = 0.1 mm. *Abbreviations:* Pedipalp: BH = basal hematodocha; Cl = column; Cy = cymbium; CyM = cymbium macrosetae; E = embolus; ED = ejaculatory duct; EM = embolic membrane; Fu = fundus; LC = lamella characteristic; LP = lateral process of lamella characteristic; M = membrane; Pcy = paracymbium; Pe = petiole; SPT = suprategulum; ST = subtegulum; T = tegulum; Ti = tibia. Epigynum: A = atrium; CD = copulatory duct; CO = copulatory opening; DP = dorsal plate; FD = fertilization duct; S = spermatheca; VP = ventral plate.

ameter of AME 0.08 (0.07-0.09), ALE 0.09 (0.07-0.11), PME 0.09 (0.08-0.09), PLE 0.08 (0.07-0.11). Separation between AME 0.06 (0.05-0.07), PME 0.08 (0.07-0.11), AME and ALE 0.11 (0.08-0.13), PME and PLE 0.13 (0.09-0.15). Clypeus height 0.25 (0.19-0.32). Length of Fe-I 2.38 (1.60-3.16), Pa-I 0.39

(0.30-0.50), Ti-I 2.03 (1.40-2.63), Me-I 2.33 (1.60-3.26), Ta-I 1.23 (0.90-1.53), Pa-II 0.35 (0.28-0.43), Ti-II 1.56 (1.08-2.03), Pa-III 0.28 (0.20-0.37), Ti-III 0.81 (0.54-1.07), Pa-IV 0.35 (0.24-0.47), Ti-IV 1.42 (0.94-2.00).

Carapace with a distinct but shallow thoracic groove. Eyes on low tubercles, anterior

eye row moderately recurved, posterior eye row slightly recurved, lateral eyes contiguous. Labium about 1.5 times wider than long, in close contact with sternum. Sternum scutiform, produced behind between coxae IV. Cheliceral base with a narrow but distinct stridulatory band on the ectal side; with a mastidion on the anterior face near to its base, varying from a sharply pointed tubercle to a reduced blunt one; anterior face of chelicerae with scattered setigerous cusps. Chelicerae with 4–5 promarginal teeth and 4–5 small retromarginal teeth. Endites with a diagonal carina on the outer half of the distal border. Legs I–II≈IV–III. Coxae IV separated by about one half of their width; Fe–I to IV with a few longitudinal ventral and lateral series of setigerous cusps, more conspicuous on Fe–I and II. Opisthosoma elongated-oval from above, about twice as long as wide; more or less rectangular in lateral view, with a scarcely developed rounded caudal tubercle.

Pedipalp: Femur with small setigerous cusps on its dorsal, and ectal faces; mesal face smooth with only 5–6 setigerous cusps in a longitudinal line (Fig. 3). Patella with a dorso-distal protuberance that supports a macroseta. Tibia about twice as long as patella (Fig. 3), and widening to its distal end (Figs. 6–8). Cy elongated, about twice as long as maximum wide, narrowing toward its tip, with a translucent, convex membrane on the proximal half of its ectal border; alveolus occupying almost all proximal face, leaving unoccupied about distal one tenth (Figs. 4–5, 7–8). PCy a small curved strip (intersegmental sensu Hormiga 1994b), similar in texture and coloration to Cy, about one sixth the Cy length, and touching the Cy membrane (Figs. 5, 8). Subtegulum transverse; tegulum trapezoidal, narrow on its distal border; suprategulum visible distal to tegulum, between the embolic division and the alveolus (Figs. 4, 5). Embolic division connected to tegulum by a membranous column. Lamella characteristic elongated, proximally directed in the not expanded bulb, pointed on its proximal tip and reaching the base of Cy (Figs. 4); with one short lateral process on its mesal side (Figs. 7, 8), that reaches the middle of the mesal border of Cy, and with an inconspicuous spine (visible only at high magnification, Fig. 4) on the opposite side (the spur of the lamella in Blauvelt's 1936 description of *F. communis*). Embolus pointed and curved

on its apex, more or less parallel to Cy, embolic membrane and membrane both parallel to embolus, ending as membranous strips that touch the embolus tip (Figs. 4, 5, 7 & 8).

Carapace almost glabrous, sternum and endites with sparse setae. Chelicerae with sparse short setae on anterior face, apex of outer sides and a few setae bordering both cheliceral margins. Legs with scattered setae, more numerous and stiff on Me and Ta; stiff setae on setigerous cusps of Fe. Bristles on legs as follows: 2 dorsal on Pa and Ti–I to IV; 1 ventral on Ti–I and II; 1 prolateral on Ti–I; 1 retrolateral on Ti–I and II; 1 dorsal and 1 ventral on Me–III; 1 dorsal on Me–IV. Opisthosoma with sparse, short setae and with two groups of long bristles on its anterior end, above each side of the pedicel.

Pedipalp: with sparse setae from femur to Cy; patella with a long distal dorsal macroseta on dorso-distal protuberance, the macroseta proximal $\frac{1}{4}$ is thick and curved to the outer side (forming an angle of about 90° from the femur axis), and the rest thin and more or less straight, tapering to a point, (Figs. 1, 2). Tibia with longer setae forming an incomplete ring near its distal border, with 2–3 retrolateral trichobothria and 1–2 prolateral trichobothria (Fig. 6). Cy with 3–4 short thick macrosetae on the distal half of its mesal border (Fig. 7). PCy with a few small setae on its distal half, visible only at high magnification (Fig. 5).

Coloration: Variations observed on both fresh and older preserved specimens. Carapace, chelicerae and endites orange-brown, pars thoracica with faint dusky radiating lines, eye tubercles black. Endites becoming white-yellow towards their tip, with a black carina on the outer half of the distal border. Sternum and labium dusky orange-brown, with borders in front of endites and rear point infuscated. Pedipalpi dusky light-green to dark orange-brown. Legs with coxae to basal two thirds of femora light orange-brown, the rest dusky light-green, darker from tibiae to tarsi. Opisthosoma creamy-gray with dorsal orange-brown tinge, and sides with a dark band and patches. Venter, caudal tubercle and spinnerets darker.

Female: ($n = 30$) Total length 5.69 (4.46–6.95), carapace length 1.96 (1.47–2.25), carapace width 1.29 (0.87–1.67). Diameter of AME 0.09 (0.08–0.11), ALE 0.12 (0.11–0.13), PME 0.11 (0.09–0.12), PLE 0.10

(0.09–0.11). Separation between AME 0.06 (0.05–0.08), PME 0.09 (0.08–0.11), AME and ALE 0.16 (0.13–0.17), PME and PLE 0.16 (0.11–0.17). Clypeus height 0.25 (0.20–0.29). Length of Fe-I 3.14 (2.56–3.56), Pa-I 0.63 (0.50–0.70), Ti-I 2.91 (2.60–3.30), Me-I 3.11 (2.40–3.55), Ta-I 1.53 (1.13–1.80), Pa-II 0.60 (0.53–0.63), Ti-II 2.25 (1.97–2.43), Pa-III 0.49 (0.43–0.50), Ti-III 1.26 (1.07–1.37), Pa-IV 0.55 (0.50–0.57), Ti-IV 2.20 (1.90–2.40).

Female similar to male except in the following characters: labium not in close contact with sternum. Cheliceral base clearly thickened proximally, without mastidia nor setigerous cusps. Tarsi of pedipalpi with one simple claw. Legs I-IV-II-III. Fe without series of setigerous cusps. Opisthosoma more or less trapezoidal in lateral view, with the rear side higher than the anterior side, and with a pronounced caudal tubercle projected beyond the spinnerets. Opisthosoma with sparse short setae on the ventral plate of epigynum. Carapace and chelicerae brown to dark brown. Sternum, labium and endites dusky brown. Pedipalpi dusky light-green, darker to the tarsi. Legs with distal half of Fe light orange-brown. All Fe with a transverse dark gray band on the distal ventral border. Opisthosoma dark brown to black, some specimens with a pair of small creamy white points on the middle of dorsum. Dorsum margined with an irregular creamy white band including the caudal tubercle, incomplete in some specimens. Sides with another irregular creamy white band at mid-height, and with four transversal (dorso-ventral) irregular discontinuous creamy white bands on the posterior half. With a diffuse patch of creamy white just above the anal tubercle.

Epigynum (Figs. 9, 10) wider than long. Ventral plate slightly convex, protruding very little from the abdominal wall. Dorsal plate about as wide as long, concave in its anterior half forming an epigynal atrium where are found the exposed rounded copulatory openings at each side, touching the border with the ventral plate (Fig. 9). In dorsal view (Fig. 10) copulatory ducts straight and short, pointing to the sides, and leading directly to the spermathecae which are curved, kidney shaped. Fertilization ducts thin, long, leaving spermathecae from the internal curvature to the midline, then making a loop around copulatory ducts, very near to the copulatory openings, and then continuing more or less straight

to the posterior border of the epigynum, in contact with the border between dorsal plate and ventral plate, and curving dorsally at the dorsal border of the genital opening (Fig. 10).

Distribution.—**MEXICO:** *Veracruz* (Postrero), *Tabasco* (Teapa), *Guerrero* (Chilpancingo), and *Chiapas* (Tonala, Mapastepec, Tapachula and Tuxtla Chico).

ACKNOWLEDGMENTS

We thank the following persons: the authorities of the Campo Agrícola Experimental Rosario Izapa, (INIFAP) for permitting us to collect in their coffee plantation; T. M. Pérez (CNAN, Instituto de Biología UNAM) for permitting us to examine the paratypes of *F. caudata* and *F. huachuca benevola*; G. Nieto (El Colegio de la Frontera Sur) for her assistance with the scanning micrographs; N.I. Platnick (AMNH) and P.D. Hillyard (NHM) kindly agreed to compare the specimens collected with the types deposited in their respective institutions; N. I. Platnick and G. Hormiga (George Washington University) and L. Leibensperger (Museum of Comparative Zoology) kindly provided useful information and important literature. G. Hormiga, M. L. Draney, J. Miller and the editors of the Journal of Arachnology made many useful suggestions for the improvement of the manuscript. This work was supported in part by a grant from the Consejo Nacional de Ciencia y Tecnología, México (CONACYT R28867-N).

LITERATURE CITED

- Austad, S.N. 1982. First male sperm priority in the bowl and doily spider, *Frontinella pyramitela* (Walckenaer). *Evolution* 36 (4):777–785.
- Blauvelt, H.H. 1936. The comparative morphology of the secondary sexual organs of *Linyphia* and some related genera, including a revision of the group. Vol. 2, pp. 81–171, *In Festschrift zum 60 Geburtstag von Professor Dr. Embrik Strand*. Riga.
- Bonnet, P. 1956. *Bibliographia Araneorum*. Tome II, 2eme partie: C-F Toulouse, Les Artisans de L'Imprimerie Doulaudore. Pp. 919–1926.
- Bonnet, P. 1957. *Bibliographia Araneorum*. Tome II, 3eme partie: G-M. Toulouse, Les Artisans de L'Imprimerie Doulaudore. Pp. 1927–3026.
- Breene, R.G., D.A. Dean, M. Nyffeler & G.B. Edwards. 1993. Biology, predation ecology and significance of spiders in Texas cotton ecosystems with a key to the species. Texas Agriculture Experiment Station, College Station (B-1711). 115 pp.

- Brignoli, P.M. 1983. A catalogue of the Araneae described between 1940 and 1981. Manchester University Press. 755 pp.
- Bryant, E.B. 1948. The spiders of Hispaniola. Bulletin of the Museum of Comparative Zoology 100 (4):331–447.
- Gertsch, W.J. & W.L. Jellison. 1939. Notes on a collection of spiders from Montana. American Museum Novitates 1032:1–13.
- Gertsch, W.J. & L.I. Davis. 1946. Report on a collection of spiders from Mexico. V. American Museum Novitates 1313:1–11.
- Hoffmann, A. 1976. Relación bibliográfica preliminar de las arañas de México (Arachnida: Araneae). Instituto de Biología, Universidad Nacional Autónoma de México, Publicaciones Especiales No. 3. México. 117 pp.
- Hormiga, G. 1994a. A revision and cladistic analysis of the spider family Pimoidae (Araneae: Araneae). Smithsonian Contributions to Zoology 549:1–104.
- Hormiga, G. 1994b. Cladistics and the comparative morphology of linyphiid spiders and their relatives (Araneae, Araneae, Linyphiidae). Zoological Journal of the Linnean Society 111:1–71.
- Kaston, B.J. 1938. New spiders from New England with notes on other species. Bulletin of the Brooklyn Entomological Society 33:173–191.
- Kaston, B.J. 1948. Spiders of Connecticut. Bulletin of the Connecticut State Geological and Natural History Survey 70:1–874.
- Kraus, O. 1955. Spinnen aus El Salvador (Arachnoidea, Araneae). Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft 493: 1–112.
- Li, S.Q. & D.X. Song. 1993. On the diagnostic characters of linyphiid spiders, with descriptions of some species (Araneae: Linyphiidae). Scientific Treatise on Systematic and Evolutionary Zoology 2:247–256.
- Millidge, A.F. 1984. The taxonomy of the Linyphiidae, based chiefly on the epigynal and tracheal characters (Araneae: Linyphiidae). Bulletin of the British Arachnological Society 6(6):229–267.
- Millidge, A.F. 1991. Further linyphiid spiders (Araneae) from South America. Bulletin of the American Museum of Natural History 205:1–199.
- Muma, M.H. 1943. Common spiders of Maryland. Natural History Society of Maryland, Baltimore. 179 pp.
- Petrunkévitch, A. 1911. A synonymic index-catalogue of spiders of North, Central and South America with all adjacent islands, Greenland, Bermuda, West Indies, Terra del Fuego, Galapagos, etc. Bulletin of the American Museum of Natural History 29:1–809.
- Pickard-Cambridge, F.O. 1897–1905. Arachnida—Araneida and Opiliones. Vol 2. In *Biologia Centrali Americana*. IX + 610 pp. + 54 plates. London.
- Platnick, N.I. 1989. Advances in Spider Taxonomy 1981–1987: A supplement to Brignoli's A catalogue of the Araneae described between 1940 and 1981. Manchester Univ. Press. 673 pp.
- Platnick, N.I. 1993. Advances in Spider Taxonomy 1988–1991, With synonymies and transfers 1940–1980. New York Entomological Society. New York. 846 pp.
- Platnick, N.I. 1997. Advances in spider taxonomy 1992–1995, With redescriptions 1940–1980. New York Entomological Society. New York. 976 pp.
- Roewer, C.F. 1942. Katalog der Araneae von 1758 bis 1940. 1 Band. Paul Budy, Bremen. 1040 pp.
- Roewer, C.F. 1954. Katalog der Araneae von 1758 bis 1940. 2 Band, Abt. b. Institut Royal des Sciences Naturelles de Belgique, Bruxelles. Pp. 927–1751.
- Rovner, J.S. 1968. Territoriality in the sheet-web spider *Linyphia triangularis* (Clerck) (Araneae: Linyphiidae). Zeitschrift fuer Tierpsychologie 25:232–242.
- Song, D., M. Zhu & J. Chen. 1999. The Spiders of China. Hebei Science and Technology Publishing House, Shijiazhuang, China.
- Suter, R.B. & G. Renkes. 1982. Linyphiid spider courtship: releaser and attractant functions of a contact sex pheromone. Animal Behaviour 30: 714–718.
- Watson, P.J. 1986. Transmission of a female sex pheromone thwarted by males in the spider *Linyphia litigiosa* (Linyphiidae). Science 233 (4760):219–221.
- Watson, P.J. 1995. Dancing in the dome. Natural History 104(3):40–43.
- Wiley-Robertson, M. & P.H. Adler. 1994. Mating behavior of *Florinda coccinea* (Hentz) (Araneae: Linyphiidae). Journal of Insect Behavior 7(3): 313–326.